

# A System Dynamics Model of Malaysia House Pricing



Muhamad Firdaus Ahmad, Hasimah Sapiri, Masnita Misiran@Bakun, Zakiah Hashim, Tisya Farida Abdul Halim

**Abstract:** *The difficulty to own a house has been a major concern especially among major cities in the world. As the worldwide issue, house prices also have been in the limelight in Malaysia. This is due to the unaffordable prices that tend to escalate over time. The factors that affect house prices are revolving around supply and demand theory either at micro or macro level. There are a lot of factors that found to be correlated as stated from the previous study such as housing characteristics, population, exchange rate, investment, inflation and liquidity. However, there have been shortcomings of study on the liquidity and investment factors toward the house prices. Therefore, this study aims to specifically analyse the influential factors of liquidity and investment toward house prices by using system dynamic approach. The model presumes the liquidity ratios stability and the amount spent on investment in residential properties will affect the house prices significantly. Analysing the trend of rising prices during recent years and forecasting its future development using system dynamic approach is significant, since it can help the authority and society to thoroughly understand on how liquidity and investment activity would affect the house prices.*

**Index Terms:** *house affordability, house price, investment liquidity, system dynamics.*

## I. INTRODUCTION

The International Labor Organization prescribes that, the ability to have a house or shelter is a minimum requirement for private consumption [1]. However, the difficulty to own a house has been a major concern especially among major cities in the world. There are two main reasons for which a person was unable to afford a house nowadays. Firstly is the house itself is expensive and secondly is the supply of housing is insufficient [2]. As a matter of fact, globalization has caused house prices to skyrocket. House prices started to increase dramatically in the mid-20<sup>th</sup> century around the world, which land cost was the main reason for the prices hike [3]. This worrisome trend had been a global issue as well due to the high housing price. In 2014, McKinsey Global

Institute has making an estimation that approximately 330 million of households around the world lived at low-quality houses due to severely unaffordable houses [4].

From the economic perspective of view, scarcity is a basic economic problem when there is a limited resources to fulfil unlimited demand [5]. Housing issue is certainly fall into this condition where land availability is limited to satisfy the demand for housing and inevitably leads to house shortage and eventually, will make the house prices to go up rapidly. House shortage problem is rooted particularly among high-dense populated cities such as Los Angeles, Sydney and Hong Kong [6].

According to the 14<sup>th</sup> Demographia International Housing Affordability Survey 2018, Hong Kong holds the least affordable house in the world for 2017 where the median house price is 19.4 times higher than household income [7]. In fact, Hong Kong had been ranked as the least affordable house in the world for 8 consecutive years started from 2010. On average, Hong Kong's citizen needs to work for 22 years, just to afford a 60m square feet flat. The house pricing is too expensive that even a car parking lot was managed to be sold at \$664,000 [8]. This unreasonable price is uncanny since Hong Kong is also renowned with several names representing their tiny living space such as cage homes, coffin apartments, nano apartments and micro-flats [9]. Two main factors were identified upon this housing prices issue in Hong Kong, which is high intensity of urban development and limited sources of land [10].

The issues of house prices also could have a substantial impact to the financial stability of the nation. Hence, any significant changes to the house prices may give an impact to the credit demand in the financial market and consequently would affect the household to fulfil their house credit obligation. One of the best recent examples is subprime mortgage crisis in 2008. Subprime mortgage crisis was caused due to the lack restriction of credit policy by relaxing the lending criteria [11]. Financial institutions like banks and hedge fund had actively involved in mortgage trading and the consequence is; most of the borrowers got default. Property market in the USA, especially housing property was collapsed and USA was facing a great recession during that period. This crisis has shown how significant of housing issues to the nation's economy. In Malaysia, the government had made an initiative to classify house as a basic need for Malaysian and in spite of that, house is also being considered as one of the key factor for economic performance indicators in Malaysia [12]. As the worldwide issue, house prices also have been in the limelight in Malaysia.

Manuscript published on 30 September 2019.

\* Correspondence Author (s)

**Muhamad Firdaus Ahmad**, School of Quantitative Sciences, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

**Hasimah Sapiri**, School of Quantitative Sciences, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

**Masnita Misiran@Bakun**, School of Quantitative Sciences, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

**Zakiah Hashim**, School of Quantitative Sciences, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

**Tisya Farida Abdul Halim**, School of Quantitative Sciences, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

This is due to the unaffordable prices that tend to escalate over time. In 2017, Malaysian Ministry of Finance had reported that, Malaysian housing property market is also experiencing an unbalanced supply-demand in which 40 percent of house is unsold, which most of the unsold houses property prices is above RM250,000. This high value is surely unaffordable to the low and middle income earners. Thus, Bank Negara Malaysia (BNM) had warned about the house affordability level in Malaysia which is in general is 'seriously unaffordable' [13]. BNM also caution about the poor supply of affordable houses. Of all the housing units launched from 2016 until first quarter of 2017, only 21 percent of the houses are below RM250,000, although the demand is higher.

The affordable house term also believed to be widely misused by developers where some of them were purposely use that term for their selling point only [14]. Moreover, BNM also reported that, the unaffordable housing issue was also worsening by the slower increase in household income compared to the increase of housing price. From 2007 until 2016, house price increase by 9.8 percent while household incomes increase by 8.3 percent only. Due to the seriously unaffordable classification by BNM, it is important to note that, the increasing of houses prices in Malaysia was not caused by bank credit policy but rather it is mainly caused by inflation and highly speculated activity especially by investors in housing property market [15]. Hence, Malaysia is unlikely to face the other version of 'subprime mortgage' crisis alike in future. However, the announcement made by the newly elected Malaysian government about the property crowdfunding project might distort the outlook given from IMF to Malaysia. Malaysia Prime Minister, Tun Dr Mahathir Mohamad had launched the crowdfunding scheme which known as 'FundMyHome' in order to ease a first-time homeowners to afford a house [16].

According to the FundMyHome official website [17], this scheme allows the person to buy a house by paying 20 percent in advance, while the remaining 80 percent will be funded by the financial institutions like banks. FundMyHome scheme does not require the homebuyers to make any monthly payments like other typical housing loans, but after five years, the homebuyers need to decide either to buy or to sell that house. This scheme nevertheless, had sparked the polemics among experts that questioning the relevancy of this scheme either it can help those first-time homeowners. For instance, Khazanah Research Institute had urged the government to reconsider the scheme as it probably will drive up the house prices more afterwards [18].

A houses price issue is very dynamic in Malaysia. A lot of studies have been done to address the house price issues and multiple factors are found to be correlated with the house price. These factors can be divided into two categories, namely internal factors and external factors [19]. An internal factor is a factor that within developer or proprietor possession such as house design, renovation, house location and building material. On the other hand, external factor is a factor that is beyond individual control such as inflation, government policy and market condition. As a matter of fact, most of the housing issues are incurred by these external factors. To discuss further about the external factors, Mariadas, Selvanathan, & Hong, [20] argue that inflation is

not the factor that affect house, instead factors like population, construction cost and speculation were among the factors that found to correlated with house prices. Construction cost however, will lead to internal factors effects as well. At the time when population increase, the demand will increase too and therefore will affect the houses price. This situation is more noticeable among high populated state like Kuala Lumpur, Selangor and Johor. The Valuation and Property Services of Malaysia reported that, in 2017 these three states experience the highest house prices increment in Malaysia which is between 6.2 percent to 7.2 percent [21]. Meanwhile, speculation activity would affect the demand as well. In particulars, investors and speculator are the main actors in this speculation activity. They actively involved in property market for investment purpose such as leasing and sell when the price is going up and consequently, the house market price will go up as well [22].

The trends of house prices movement is determined by a multiple factor. Generally, prices are solely determined by supply and demand theory [23]. Demand is a consumer desire to obtain any particular product or services, while supply is a product or services available, to offer to the consumer. That being said, the factors that affect house prices are revolving around supply and demand theory either at micro or macro level [24]. Housing characteristic such as size of house, lot size, house location, number of bedrooms, number of bathrooms and houses building material are among the factors that affect house prices at micro level [25].

At macro level, inflation rate, employment rate and exchange rate were found to be significant factors towards housing prices [26]. Besides that, recent research by Hashim et al., have shown that, there are four key factors that happen to affect house pricing. The factors are population, inflation, liquidity and investment [27]. However, this study merely concentrates on population and inflation factors and did not quest further on how liquidity and investment affect housing prices. Furthermore, the study also in accordance with Taltavull & White [28], where they have stated that, liquidity and investment were among the factors that interrelated with house prices changes.

Yet, there is still inadequacy of research on liquidity and investment factors to the houses prices. Notwithstanding, the capability of system dynamic (SD) modeling technique to imitate the real world situation by illustrating the feedback structure and the outcomes behaviour, appeared to be a viable option to address the housing issues [29]. Therefore, this study however, aims to specifically analyse the influential factors of liquidity and investment toward house prices by using SD approach. This paper is aligned with the objective of National Housing Policy initiated by the Housing and Local Government Ministry of Malaysia, which aim to produce an adequate and quality house to the Malaysian [30].

Analysing the trend of rising prices during recent years and forecasting its future development using SD approach is significant since it can help the authority and society to thoroughly understand on how liquidity and investment activity would affect the housing prices.

SD will able to illustrate the cause and effect of the influential factors in examining houses problem specifically in housing prices issues.

**II. DETERMINANT FACTORS IN HOUSE PRICES**

In this study, we will investigate two factors that relate to structural diagram of house prices –liquidity and investment.

**A. Liquidity**

Liquidity is a concept, applied on the degree of trading activities, related to particular assets. Thus, whenever cash or deposit money took place during or after the transaction (sale of assets or credit payment obligations), then it would be called as liquidity [31]. That is, the easier the asset or security can be converted into cash; consequently it would affect the market trading and the price as well.

The concern with the liquidity to the houses prices, had been reviewed thoroughly by Amihud, Mendelson, & Pedersen (2005) using past literature. They conclude that, liquidity has an effect to the asset price but the measurement of liquidity itself cannot achieve a satisfactory accuracy level, due to the multidimensional of the liquidity [32]. However, Banks, (2014) argue that, although liquidity is difficult to measure, but with an appropriate mechanism, liquidity can be measured correctly [33]. Meanwhile, as regard to the house price issues, liquidity is referred to the period of waiting time that any particular houses which manage to get sold, once the house put ‘for sale’ [34]. Moreover, they added that there is a positive correlation between liquidity and house price; whenever the liquidity of house increase, the house prices will increase as well. This is due to the notion that, the expected profit gains in the property market occurred if the trading is easily executed.

Liquidity on the other hand can affect the expected return in housing investment as well [35]. This is due to the illiquid nature of housing transactions over time and consequently, the house prices cannot be accurately identified. This finding is also consistent with Koss & Shi, (2018) when liquidity played an important factor in China’s housing price [36]. Instead of housing price, liquidity also influence the mortgage loans rate as well. It is widely accepted that, property is relatively illiquid [37]. Hence, most investor perceived property as a long-term investment with low risk but the return is worthy.

**III. INVESTMENT**

Other than liquidity, investment also played a major role in housing market. By definition, investment is an asset or item purchased with the expectation that, it could generate more income or profit after a certain period of time [38]. Investment activity in the residential property or housing market has been enterprising among investors to date due to its appreciating value for the time being. Hence, it is vital to measure the value of residential property in order to substantiate investment decisions and also to avoid that particular property is overpriced or underpriced. For the record, Ataguba (2017) had discussed about the most common method used to measure the value of freehold property which is equivalent yield method [39]. Equivalent yield method is actually consists of two part. The first contain

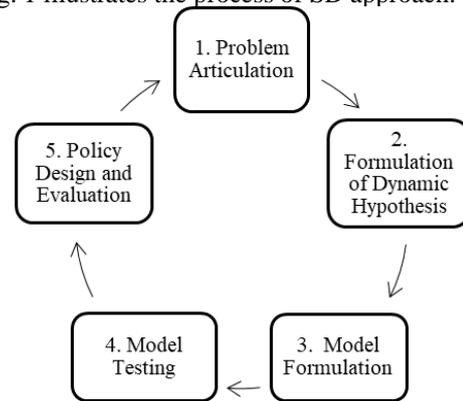
the contract rent until the next rental contract review. The second part is the basis of pre-rental contract reviewed upon the market rent value which is assumed to be constant in eternity. There are three main variable involved in equivalent yield method which are, market rent, contract rent and the number of years between the current rental contract until the next rental contract reviewed.

Occasionally investors’ activity had affected the housing market prices in which the house prices are higher than its actual price [40]. If the situation was not handled properly, it might lead to price bubbles and eventually, the financial crisis could hit the economies like what happened during Asian financial crisis, the Dot-Com crisis and the global financial crisis. All these crises were sparked by the crash of price bubbles in asset markets such as property market.

Iacoviello & Neri (2010) have provide an in-depth and through analysis on the volatility of housing market and housing prices which involve with 40 years historical data by using Bayesian method [41]. In view of the foregoing discussions, housing prices and housing investment was proven to be highly correlated and besides, it is also sensitive to any market changes.

**IV. METHODOLOGY**

If SD is one of a simulation technique that practically used to grasp the behaviour or trend which is complex and dynamic [42]. Fig. 1 illustrates the process of SD approach.



**Fig. 1.** The process of SD approach

**A. Problem articulation.**

The first step is to define the model purpose and articulate it with a particular problem. To ascertain this step is managed to get further, several processes should be carry out [43]. Firstly, the purpose of the model must be appropriately defined. Secondly, the key variables that desire to be inserted into the model must be identified. Thirdly, constructs a reference mode. Next, determine the time horizon in order to ensure the developed model can be claimed to be true for a certain time horizon only. Lastly is the level of aggregation where it is depending on the amount of internal categories or stocks.

**B. Formulation of Dynamic Hypotheses**

The data is collected from Department of Statistics Malaysia (DOSM) and CEIC Data in this research.



This SD model of house prices comprised of four subsystem that have been identified that found to give an impact on the house prices. The subsystems are liquidity, investment, population and inflation as shown in the following Fig 2. The shaded area in the following Fig 2 shows that the further analysis in this research will concentrate on investment and liquidity subsystems only because population and inflation subsystem have been studied by Z. Hashim et al., (2018) [27].

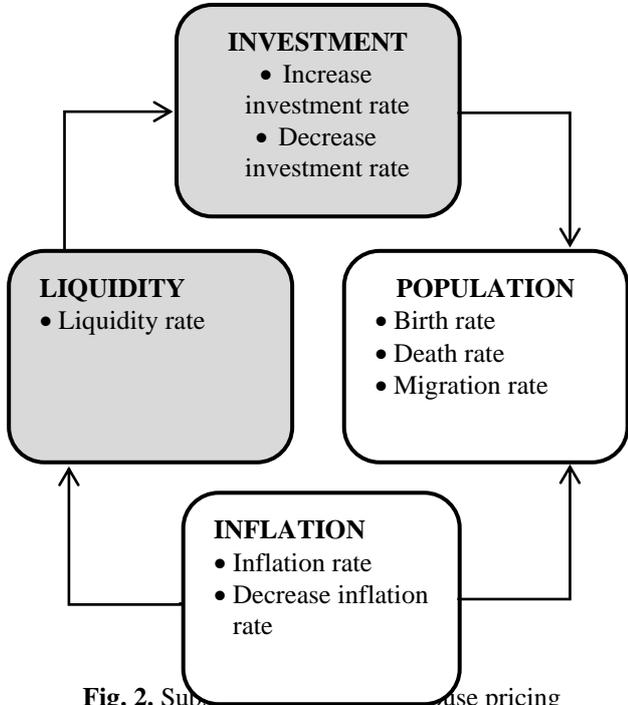


Fig. 2. Subsystem of house pricing

C. Model Formulation

The liquidity and investment subsystems were transformed into a stock and flow and simulated by Vensim software.

Liquidity

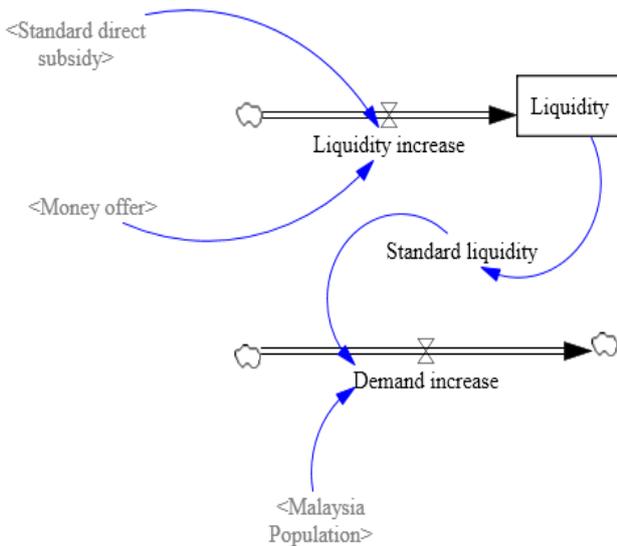


Fig. 3. Stock and flow model for liquidity subsystem

The following Fig 3 indicates the demand for housing is correlated with the number of population. Therefore, if the Malaysia population increases, the demand for housing would definitely increase as well. The rising of Malaysia

population had largely contributed to the rising of demand for housing in Malaysia [44]. According to Department of Statistic Malaysia (2018), the growth rate of Malaysia population for 2017 to 2018 is 1.1% [45]. Thus, it is estimated that Malaysian had reached 32.4 million populations in 2018 as compared to 2017 where the estimated of Malaysian population is 32 million. Likewise, it is expected to see an increasing demand for housing too. Besides that, the demand for housing also gets affected by the level of liquidity, where the loose of liquidity would increase the money supply and consequently increase the demand to own a house [46].

Moreover, it is suffice to say that liquidity would likely to remain stable through the practice of standard liquidity by Bank Negara Malaysia (BNM). BNM had pledge to maintain a sufficient liquidity in order to support intermediation and meet the exigent needs [47]. As a matter of fact, BNM is a statutory body in Malaysia that helps and advises the government to promote monetary and financial stability. Besides of the role of BNM to maintain sufficient liquidity, money supply which is also being monitored by BNM, can affect the liquidity to increase as well. According to Chung, Ariff, & Shamsheer, (2012), there is a significant relationship between positive money supply and liquidity [48]. Furthermore, besides of money supply effects on liquidity, standard direct subsidy also affecting the liquidity to increase over time.

Investment

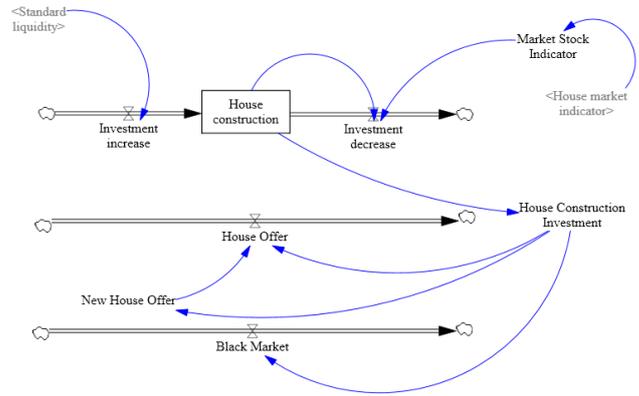


Fig. 4. Stock and flow for investment subsystem

Fig 4 showed the standard liquidity would affect the investment level to go up and consequently, the investment on housing construction would increase as well [49]. In spite of that, the investment would go down as a reaction from market stock indicator. At the time when the stock market doing well, the investment in the housing sector would be less attractive [50]. House offer also one of the factors that increases the investment level, as the result of new houses offered for the people [51], [52]. By offering more houses in the market, the investors would vying for more housing investment. Apart from that, once the investment activity has been level up, the issues of black market will certainly took place due to the profit gain expected from housing investment.

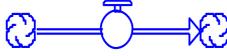
Generally, black market is a situation where any unlicensed or unrecorded economic activities in order to avoid paying taxes or any related charges [53]. Black market which also being expressed in other expression such as shadow, informal or underground economy was found to be actively occurred in Malaysia residential property market.

Due to the hassles procedures of law enforcement and the nonexistence of the specific law regarding landlords and tenants, there are high possibilities for each parties to violate the tenancy agreement [54], [55]. For example, there exist a

lot of cases where the registered tenants under the People’s Housing Scheme (PPR) have been illegally sub-letting their house to third party for the higher prices [56]. Apart from that, buy-to-lease property scheme was introduced in order to provide a platform for investors to involve in residential property market but the market is still limited in Malaysia today [57]. Therefore, some investor had resort to unlawful buy-to-lease property scheme.

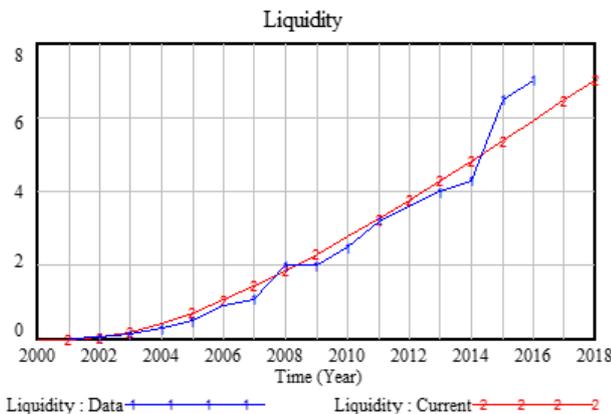
The description of each elements and symbol in Fig. 2 and Fig. 3 are explained in following Table 1.

**Table- I:** The description of stock and flow elements and symbols [58]

Element	Description	Symbol
Stock	Acts as a reservoir to accumulate quantities	<p>Stock</p> 
Flow	Inflow and outflow	 <p>Flow</p>
Converters	A factor affecting inflow or outflow	 <p>Converters</p>
Connecters	Cause-effect link within the model structure.	 <p>Connecters</p>

**I. RESULT AND DISCUSSION**

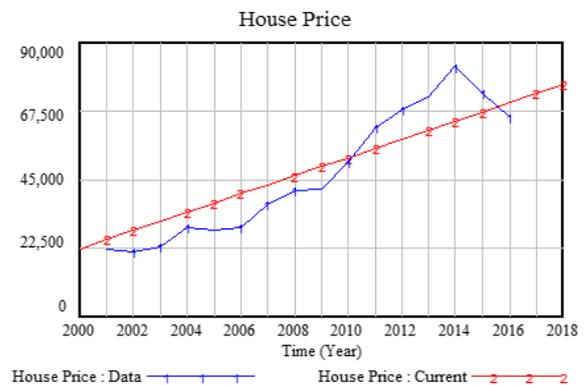
Once the stock and flow model for liquidity and investment have been formulated, then the model will be tested for validation purposes in order to establish the robustness of the model, either the model is truly representative for the real world situation in housing cases. The first part of model testing process is structural validation, have been done through the past literature review over the house price issues. The second part of model testing is behavioural validity test by comparing with the real data as shown in Fig. 5 and Fig. 6.



**Fig. 5.** Behaviour verification for liquidity

Fig 5 shows the graph for behaviour verification for liquidity. The graph showing that the pattern for both base case run and the references mode line graphs are parallel. Therefore, it is indicate that the behavioural test for liquidity is validated. Meanwhile, the pattern for behavioural

verification for house price show otherwise in Fig 6.



**Fig. 6.** Behaviour verification for house prices

There is a slight deviation recorded between the base case run and the reference mode graph line for both Fig 5 and Fig 6, especially from 2014 to 2016. Two main factors were identified that presume to be the causes of this deviation; Goods and services tax (GST) implementation [59] and housing market bubble [60].

**II. CONCLUSION**

The effects of liquidity and investment to the house prices are apparent towards the house price which is successfully illustrated through simulation model.



All these factors work like a sequence and interconnected to the house prices. In conclusion, the simulation model obtained for the liquidity and investment on house prices are proven to be valid and truly reflecting the house prices situation. Thus, liquidity and investment will continuously affect the house prices in the long run.

### ACKNOWLEDGMENT

The authors wish to thank the Universiti Utara Malaysia in funding this study under the University Grant Scheme, S/O code 13872, and Research and Innovation Management Centre, Universiti Utara Malaysia, Kedah for the administration of this study.

### REFERENCES

1. J. H. Cobbe, "Employment, Growth and Basic Needs: A One World Problem," *Journal of Modern African Studies*, vol. 14, no. 4, pp. 713-715, 1977.
2. M. M. Nor, S. M. Shaharudin, S. L. Khoo, S. G. Parthiban, and H. Zahri, "Kemampuan Memiliki Rumah dalam Kalangan Keluarga Bandar di Malaysia," *Geografi*, vol. 5, no. 2, pp. 69-77, 2017.
3. K. Knoll, M. Schularick, and T. Steger, "No price like home: Global house prices," *American Economic Review*, vol. 107, no. 2, pp. 331-353, 2017.
4. J. Woetzel, S. Ram, J. Mischke, N. Garemo, and S. Sankhe, *A Blueprint For Addressing The Global Affordable Housing Challenge*, McKinsey Global Institute, 2014.
5. J. H. Brown, J. R. Burger, W. R. Burnside, M. Chang, A. D. Davidson, T. S. Fristoe, and J. G. Okie, "Macroecology meets macroeconomics: Resource scarcity and global sustainability", *Ecological Engineering*, vol. 65, pp. 24-32, 2014.
6. A. Millington, (2018, January 22). The 10 most expensive cities to live in around the world in 2018, *Business Insider*.
7. C. Saputelli, and M. Holzhey, *UBS global real estate bubble index*, Zurich, 2018.
8. A. Ramzy, (2017, June 15). A \$664,000 Parking Spot Symbolizes Hong Kong's Property Frenzy, *The New York Times*, 2017.
9. H. Jacobs, (2018, May 22). Could this be the solution to Hong Kong's housing crisis? *World Economic Forum*, 2018.
10. B.-sin. Tang, and C. Y. Yiu, "Space and scale: A study of development intensity and housing price in Hong Kong," *Landscape and Urban Planning*, vol. 96, no. 3, pp. 172-182, 2010.
11. Y. Demyanyk, and O. Van Hemert, "Understanding the subprime mortgage crisis," *Review of Financial Studies*, vol. 24, no. 6, pp. 1848-1880, 2011.
12. M. S. Suhaida, N. M. Tawil, N. Hamzah, A. I. Che-Ani, H. Basri, and M. Y. Yuzainee, "Housing affordability: A conceptual overview for house price index", *Procedia Engineering*, vol. 20, pp. 346-353, 2011.
13. S. L. Cheah, S. Almeida, M. Shukri, and L. L. Sze., Imbalances in the Property Market, *BNM Quarterly Bulletin*, 2017.
14. Z. A. Hashim, "House Price and Affordability in Housing in Malaysia [ Harga Rumah dan Tahap Mampu Milik Rumah di Malaysia," *Jurnal Akademika*, vol. 78, pp. 37-46, 2010.
15. International Monetary Fund. Malaysia: Financial Sector Stability Assessment. *International Monetary Fund (IMF)*. Washington, 2013
16. V. Tan, (2018, November 4). "PM launches FundMyHome scheme to help first time home owners." *The Star*, 2018.
17. FundMyHome.com. (2018). Retrieved December 23, 2018, from <https://www.fundmyhome.com/>
18. E. Yeong, (2018, November 13). "Khazanah research arm urges govt to reconsider property crowdfunding scheme," *The Sun Daily*, 2018.
19. N. Hamzah, M. A. Khoiry, M. A. Ali, N. Zaini, and I. Arshad, "Faktor Luaran dan Dalaman yang Mempengaruhi Harga Rumah Teres Di Bandar Baru Bangi," *Journal Design + Built*, vol. 4, pp. 1-8, 2011.
20. P. A. Mariadas, M. Selvanathan, and T. K. Hong, "A Study on Housing Price in Klang Valley, Malaysia," *International Business Research*, vol. 9, no. 12, 2016.
21. Jabatan Penilaian dan Perkhidmatan Harta. (2018). Laporan Indeks Harga Rumah Malaysia, 2018.
22. I. Natasha, and Z. Hassan, "Factors that influencing property investment decisions among Employees in Felcra Bhd," *International Journal of Accounting, Business and Management*, 2015.
23. E. J. Working, "What Do Statistical "Demand Curves" Show?" *The Quarterly Journal of Economics*, vol. 41, no. 2, pp. 212-235, 1927.
24. M. A. Khoiry, N. M. Tawil, N. Hamzah, A. I. C. Ani, and S. Sood, "Critical Factors Affecting Double Storey Terrace Houses Prices in Bandar Baru Bangi," *Procedia - Social and Behavioral Sciences*, vol. 60, pp. 562-566, 2012.
25. J. Zietz, E. N. Zietz, and G. S. Sirmans, "Determinants of House Prices: A Quantile Regression Approach," *The Journal of Real Estate Finance and Economics*, vol. 37, no. 4, pp. 317-333, 2008.
26. S. Pillaiyan, G. W. Kiat, H. B. Han, N. C. Yet, P. K. Hao, T. S. Hui, and C. L. Lee, *Macroeconomic and Financial Determinants of Malaysian Residential Property Market*, Canadian Social Science, 2015.
27. Z. Hashim, H. Sapiri, M. Misiran, and T. F. Abdul Halim, "The Utilization of System Dynamics for House Pricing Analysis in Malaysia," *International Journal of Supply Chain Management*, vol. 7, no. 4, pp. 272-278, 2018.
28. P. Taltavull de La Paz, and M. White, "The sources of house price change: identifying liquidity shocks to the housing market," *Journal of European Real Estate Research*, vol. 9, no. 1, pp. 98-120, 2016.
29. M. Shin, H. S. Lee, M. Park, M. Moon, and S. Han, "A system dynamics approach for modeling construction workers' safety attitudes and behaviors," *Accident Analysis and Prevention*, vol. 68, pp. 95-105, 2014.
30. Jabatan Perumahan Negara. (2013). Dasar Perumahan Malaysia 2013.
31. A. Acs, *The Evolution of Liquidity*, SSRN, 2014.
32. Y. Amihud, H. Mendelson, and L. H. Pedersen, "Liquidity and Asset Prices," *Foundations and Trends® in Finance*, vol. 4, pp. 269-364, 2005.
33. E. Banks, Measuring liquidity risk. In *Liquidity Risk*. London: Palgrave Macmillan, pp. 155-187, 2014.
34. A. Head, H. Lloyd-Ellis, and H. Sun, "Search, liquidity, and the dynamics of house prices and construction," *American Economic Review*, vol. 104, no. 4, pp. 1172-1210, 2014.
35. M. Hwang, and J. M. Quigley, "Housing price dynamics in time and space: Predictability, liquidity and investor returns," *Journal of Real Estate Finance and Economics*, vol. 41, no. 1, pp. 3-23, 2010.
36. R. Koss, and X. Shi, "Stabilizing China's Housing Market," *IMF Working Paper*, vol. 89, no. 18, p. 33, 2018.
37. M. N. Razali, "Expert - Based Forecasting For Malaysian Property Markets," *Journal of Technology Management and Business*, vol. 02, no. 02, pp. 1-26, 2015.
38. M. Feldman, T. Hadjimichael, and L. Lanahan, "The logic of economic development: a definition and model for investment," *Environment and Planning C: Government and Policy*, vol. 34, no. 1, pp. 5-21, 2016.
39. J. O. Ataguba, "Methodologies for Equivalent Yield Calculation and their Implications for Property Investment Pricing," *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, vol. 5, no. VIII, pp. 120-137, 2017.
40. M. S. Yiu, and L. Jin, Detecting Bubbles in the Hong Kong Residential Property Market: An Explosive-Pattern Approach, 2012.
41. M. Iacoviello, and S. Neri, Housing market spillovers: Evidence from an estimated DSGE model. *American Economic Journal: Macroeconomics*, vol. 2, no. 2, pp. 1-44, 2010.
42. H. Sapiri, A. A. Kamil, and R. M. Tahar, "System Dynamic Approach As A Risk Management Tool In Analyzing Pension Expenditure: The Case Of Malaysian Employees Public Pension Plan," *The Singapore Economic Review*, vol. 59, no. 05, 2014.
43. K. Saeed, "Defining a Problem or Constructing a Reference Mode," *Social Science and Policy Studies*, pp. 1-29, 1998.
44. A. R. Abdul Aziz, N. Mine, L. L. Tat, S. Y. Tan, and A. Olanrewaju, "Market Analysis of Housing Shortages in Malaysia," *Procedia Engineering*, vol. 164, pp. 315-322, 2016.
45. Department of Statistics Malaysia. (2018). Current Population Estimates, Malaysia, 2017-2018. Department of Statistics Malaysia. <https://doi.org/10.1017/CBO9781107415324.004>
46. T. W. Kuen, Meeting the Needs of Homeownership. In *Housing the Nation: Policies, Issues and Prospects*. Kuala Lumpur: Cagamas Holdings Berhad, pp. 3-22, 2013.
47. "Monthly Highlights January 2019," *Bank Negara Malaysia*. Kuala Lumpur, 2019.
48. T. Chung, M. Ariff, and M. Shamsher, "Money Supply, Interest Rate, Liquidity and Share Prices: A Test of Their Linkage," *Global Finance Journal*, vol. 23, no. 3, 212, pp. 202-220.
49. R. Paramesan, The Role of the Banking System. In *Housing the Nation: Policies, Issues and Prospects* (pp. 137-148). Kuala Lumpur: Cagamas Holdings Berhad, 2013.

50. I. D. Trofimov, N. M. Aris, and D. C. D. Xuan, "Macroeconomic and Demographic Determinants of Residential Property Prices in Malaysia," *Munich Personal RePEc Archive*, pp. 1-24, 2018.
51. C. Ferlito, Affordable Housing and Cyclical Fluctuations: The Malaysian Property Market (No. 51), Kuala Lumpur, 2018.
52. N. F. Mohd Razif, N. S. Samsul Kamal, S. Mohamad, and A. Hashim, "Excessive Speculation and Its Regulation on House Prices: a Malaysia Experience," In *15th International Conference on Social Sciences, Business, Technology and Management (SBTM-DEC-2017)*, 2017.
53. Y. L. Tan, M. S. Habibullah, and T. H. Yiew, "The Shadow economy in Malaysia: Evidence from an ARDL model," *International Journal of Economics and Management*, vol. 10, no. 2, pp. 261-277, 2016.
54. A. Amirullah, A. Fazira, and A. Salman, "Illicit Trade in Malaysia: Causes & Consequences," vol. 44, pp. 1-16, 2017.
55. A. Sufian, "A Conceptual Study On Landlord And Tenant Law In Peninsular Malaysia: A Focus On Private Residential Tenancy," *International Journal of Real Estate Studies*, vol. 7, no. 1, pp. 13-23, 2012.
56. S. Bavani, and K. Ashok. (2012, September 4). Tenants of low-cost flats sub-letting their units for higher rental, StarProperty.My, 2012.
57. T. A. Leng, (2015, September 23). Investing in buy-to-lease property schemes, EdgeProp Sdn Bhd, 2015.
58. H. Sapiri, J. Zulkepli, N. Ahmad, N. Zainal Abidin, and N. N. Hawari, *Introduction to System Dynamics Modelling and Vensim Software*, Kedah: Universiti Utara Malaysia Press, 2017.
59. R. Zainal, T. Chai Teng, and S. Mohamed, "Construction Costs and Housing Prices: Impact of Goods and Services Tax," *International Journal of Economics and Financial Issues*, vol. 6, 2016, pp. 16-20.
- C. Yin Yip, W. C. Wong, and H. Eam Lim, "Bubble Detection in the Malaysian Housing Market," *Malaysian Journal of Economic Studies*, vol. 54, no. 2, 2017, pp. 203-2017.

illiterate citizen that may dampen the country's growth economically and socially



**Zakiah Hashim** is a lecturer in School of Quantitative Sciences, Universiti Utara Malaysia. She holds Bachelor in Actuarial Science from Universiti Teknologi Mara, Shah Alam, Malaysia and Master degrees in Decision Science from Universiti Utara Malaysia. She is currently active in research activities including optimization models and some mathematical models. She also interested in investigating problems that are applied in nature which includes tourism and routing problem. To date, she has successfully published 7 research articles in international and national refereed journals, and 7 research articles in international and national conference proceedings. She also published 2 chapter in book. Her current research interest include problem in optimization models in routing problem and also mathematical model. Zakiah is also passionate in research works and activities that involved with social community enhancement.



**Tisya Farida Abdul Halim** is a PhD student in School of Quantitative Sciences, Universiti Utara Malaysia. She holds a Bachelor degree in Mathematics from Universiti Teknologi MARA, Shah Alam, Selangor and a Master degree in Decision Science from Universiti Utara Malaysia, Sintok, Kedah. Her current research interest includes problems in mathematical model, system dynamics and multi-criteria decision making. She is also interested in investigating problems that are applied in healthcare specifically tobacco control. To date, she has successfully published 7 research articles in international and national refereed journals and presenting her works in international conferences.

#### AUTHORS PROFILE



**Muhamad Firdaus Ahmad** is master's student at Universiti Utara Malaysia, studying for an MSc in Data Analysis. He holds a Diploma in Quantitative Science and Bachelor in Management Mathematics from Universiti Teknologi Mara, Malaysia.



**Hasimah Sapiri** is a senior lecturer in School of Quantitative Sciences, Universiti Utara Malaysia. She holds a Bachelor and Master degrees in Mathematics from Universiti Kebangsaan Malaysia, Bangi, Malaysia and Universiti Teknologi Malaysia. She also holds a PhD degree in Operations Research from Universiti Sains Malaysia. She is currently active in research activities including methodological development of some mathematical models, and computer simulation. She also interested in investigating problems that are applied in nature which includes pension and healthcare problem. To date, she has successfully published 28 research articles in international and national refereed journals. She also published 2 mathematical books. Her current research interest include problems in financial mathematics, risk analysis, mathematical model and system dynamics. Hasimah is also passionate in research works and activities that involved with social community enhancement.



**Masnita Misiran** is a senior lecturer in School of Quantitative Sciences, Universiti Utara Malaysia. She holds a Bachelor and Master degrees in Mathematics from Universiti Kebangsaan Malaysia, Bangi, Malaysia, and a PhD degree in Financial Mathematics from Curtin University, Perth, Australia. She is currently active in research activities including theoretical and methodological development of some mathematical models, and also investigating problems that are applied in nature. To date, she has successfully published 29 research articles in international refereed journals, presenting her works in international conferences, and has been invited to deliver two keynote address during her career. Her current research interest include problems in financial mathematics, econometrics, risk analysis, approximation theory, dynamical system, and system dynamics. She has also successfully involved with research project with several industries, i.e. improving the system of delivery among franchisee in Nelson's Franchise Sdn. Bhd. and detecting the risk of hazard for shrimp's survival in Blue Archipelago Sdn. Bhd. Masnita is also passionate in research works and activities that involved with social community enhancement and student's development in all level of education. Her current interest in this area is on the effort of improving financial literacy among Malaysian to reduce Malaysia's collective risk of